

Radionuclide IMS Network QA/QC programme

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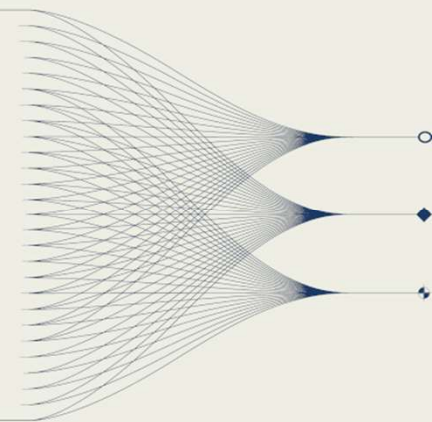
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..... INTRODUCTION AND MAIN RESULTS

An additional element of the radionuclide (RN) stations' quality assurance (QA) programme is the verification of station performance through the independent measurements and analysis of network quality control (QC) samples. These samples are sent from the International Monitoring System (IMS) RN stations to certified radionuclide laboratories (RLs). The objective of this Network QA/QC Programme is to assess station performance and ensure the reliability of sample handling and shipment procedures at the stations. The evaluation is based on ^7Be metrics, as this nuclide is consistently present in adequate concentrations in station samples. A global overview of the Network QA/QC results and Level 5 statistics for 2023 and 2024 is presented. The presentation provide the verified metrics used by PTS. Overall, the 2023–2024 data demonstrate that the IDC and RLs results for Network QA/QC and Level 5 samples are in good agreement, confirming the reliability and effectiveness of the ^7Be -based metrics.

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Introduction

The PTS operates the Network QA/QC programme on a periodic and ongoing basis. Network QA/QC particulate samples are randomly selected from station samples that have been reviewed and categorized as Level 1–4 (Category A) or Level 5 (Category B) for reanalysis, in order to verify system calibrations. Typically, one sample per quarter from each certified station (73 IMS stations) is sent to one certified radionuclide laboratory (14 RLs). All selected Network QC samples meet the minimum requirements specified for IMS radionuclide stations. Level 5 samples are considered as high-priority, as they are related to the verification regime. At the station, each Level 5 sample is split into two parts: the first half of the samples is sent to the geographically closest laboratory, while the second to a randomly selected one.

Samples category

The presentation is focused of the following two types samples category send for analysis at a RLs:

Category A: Network QC samples: routine samples regularly sent from IMS radionuclide particulate stations to assess the performance of the RN network (Level 1 to Level 4).

Category B: High priority samples: samples categorized as Level 5 within the International Data Centre (IDC) event categorization and screening process, or routine samples from stations exercised as high priority samples to maintain preparedness and necessary procedures.

Laboratory and sample selection criteria

In general, the selection is randomized.

Some RLs may be excluded due to:

- being not operational or not available;
- Proficiency Test Exercise (PTE) failure;
- deselection rules (the State Party hosting the station is allowed to deselect not more than 25% of the certified laboratories to which the sample may be sent).

Sample selection is randomized from the list of last 20 samples for which the spectrum has been released by the IDC. A category priority is given to samples with detected anthropogenic radionuclides (Level 3 and Level 4 samples).

Result comparison metrics

The ^7Be metrics are aligned with ISO 13528:2022 - Statistical methods for use in proficiency testing by interlaboratory comparison (Clauses 9.4.2 and 9.6.2). Two statistical parameters are used to evaluate station results: (1) Percent Difference (**%D**) – the deviation of station results (IDC) from laboratory results, used as a reference values; (2) **ζ-score** – the two results statistical comparison:

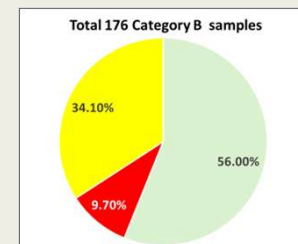
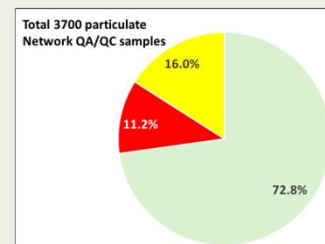
$$\%D = \frac{A_{IDC} - A_{LAB}}{A_{LAB}} \times 100 \quad (1) \quad \zeta = \frac{A_{IDC} - A_{LAB}}{\sqrt{u_{IDC}^2 + u_{LAB}^2}} \quad (2)$$

The table below summarizes the Network QA/QC metrics, their interpretation, and the corresponding PTS warnings and recommended actions.

D %	Logical condition	ζ score	Other conditions	Interpretation of the result	PTS Warning/Action
≤ 15 %	AND	ζ ≤ 2	None	In agreement	None
≤ 15 %	AND	2 < ζ < 3	None	Questionable	Warning: Monitor station for indication of bias or continued scatter of results
≤ 15 %	AND	ζ ≥ 3	None	Not in agreement	Warning: Monitor station for indication of bias or continued scatter of results
> 15 %	AND	ζ ≤ 2	None	Not in agreement	Warning: Monitor station for indication of bias or continued scatter of results
> 15 %	AND	2 < ζ < 3	None	Not in agreement	Warning: Monitor station for indication of bias or continued scatter of results
> 15 %	AND	ζ ≥ 3	Single observation	Not in agreement	Warning: Monitor station for indication of bias or continued scatter of results
> 15 %	AND	ζ ≥ 3	≥ 3 observations	Not in agreement	Action: Look for the reason and corrective action for bias or scatter

Verification of the metrics

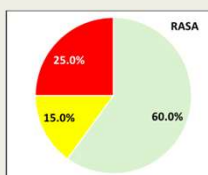
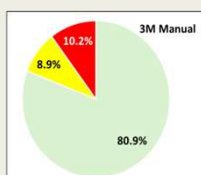
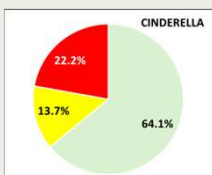
The above-described metrics were verified using the received RLs reports (RLRs) for the analysed station samples. A total of 3 876 reports received until 28 July 2025 were analysed: 3 700 ^7Be results for Network QA/QC Category A and 176 for Category B samples. A summary of the analysis based on the dual criteria (%D and ζ-score) is presented in the following figures:



The verification of metrics for Category A samples showed that 72.8% of results were in agreement with the laboratory analyses, 11.2% were classified as questionable, and 16.0% were not in agreement. For Category B samples, 56.3% of results were in agreement, 34.1% were classified as questionable, and 9.7% were not in agreement. These results indicate that while the majority of stations demonstrate satisfactory performance, a notable proportion of results require further review and potential corrective actions to ensure consistent compliance with the established metrics.

The verification of metrics was also conducted separately by RN technology (CINDERELLA, 3M MANUAL and RASA). The results are as follows:

Metrics	CINDERELLA	Metrics	3M Manual	Metrics	RASA	%
In Agreement	182	In Agreement	1800	In Agreement	713	99.92%
Questionable	39	Questionable	198	Questionable	179	15.04%
Not in agreement	63	Not in agreement	228	Not in agreement	296	25.04%
Total	284	Total	2226	Total	1190	100.0%



Overall, these confirms that the PTS has appropriately selected the ⁷Be-based result comparison metrics for assessing a station performance.

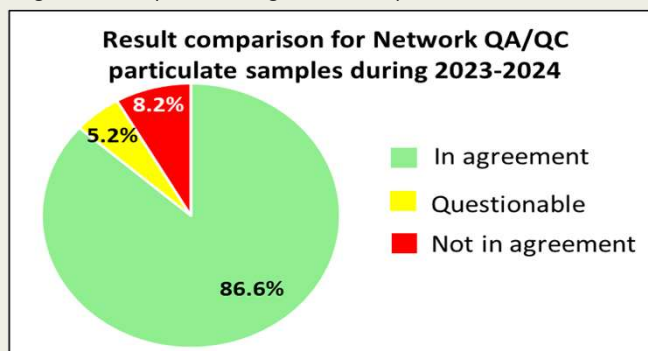
*WHO declared that COVID-19 was no longer a Public Health Emergency of International Concern.

Result comparison for Network QA/QC and Category B samples (2023 and 2024)

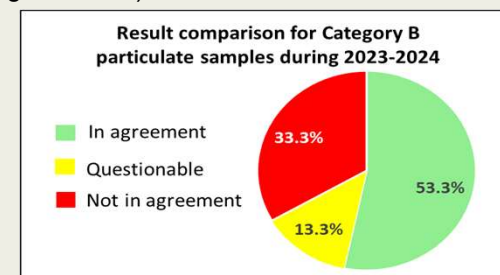
In 2023 and 2024, a total of 573 particulate samples - 483 Network QA/QC samples and 15 Category B samples, were analysed by 14 certified RLs. A summary of the result comparison is provided in the table below.

Year	Sample category	Number	Interpretation of the result		
			In agreement	Questionable	Not in agreement
2024	A	295	257	13	25
	B	7	2	2	3
	A+B	302	259	15	28
2023	A	263	226	16	21
	B	8	6	0	2
	A+B	271	232	16	23

The result comparison for the Network QA/QC Category A samples showed that 86.6% of results were in agreement with laboratory analyses, 5.2% were classified as questionable, and 8.2% were not in agreement (see the figure below)



The result comparison for the Category B samples showed that 53.3% of results were in agreement with laboratory analyses, 13.3% were classified as questionable, and 33.3% were not in agreement (see the figure below).



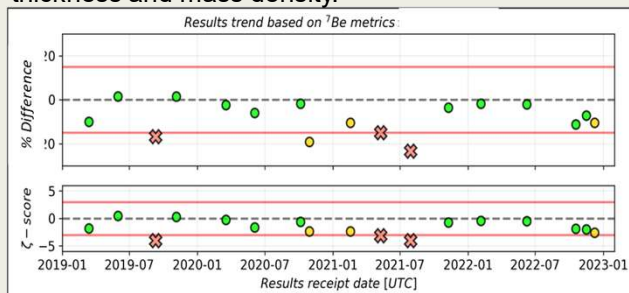
Sample analysis cancellation

During the period 2023–2024, the analysis of 46 samples was cancelled due to various issues encountered during the shipment, which prevented the samples from reaching the RLs. The primary reasons for these cancellations include:

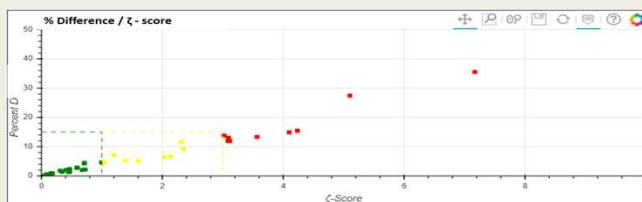
- Extended shipment durations;
- Lack of available postal services;
- Samples returned to the station due to customs issues;
- Loss of samples during the transportation;
- Laboratory detector malfunctions;
- Incorrect samples sent by the stations;
- Restrictions related to COVID-19 (up to 05 May 2023*).

Examples of PTS Warning/Actions

Example 1: A seasonal sandstorms during the boreal summer coincided with the discrepant results. The samples may have exhibited higher variability in final thickness and mass density.



Example 2: Detector resolution degradation at the station was identified.



SRID	z-score	%D	Comments / Actions taken
XX202402122211	5.09	27.39	In October 2023 the detector was changed due to bad resolution. The new detector was working properly. A wrong efficiency calibration pairs were identified. The detector was recalibrated. Later an issue with the resolution was observed. It was decided to change the detector again.
XX202404082211*	7.17	32.52	

*Type E sample sent to the radionuclide laboratory for SAV

Example 3: No any technical issues were identified with the station detection system.

SRID	z-score	%D
XX202311230611	4.02	-17.54
XX202403070611	4.40	-18.87

It was decided to conduct a new calibration of the detector with expert support from the PTS, as this was the second calibration of the detector (the previous one was performed in 2022 by the SO). Following the recalibration, the QC result comparison returned to acceptable values.

Conclusion

Overall, the 2023–2024 data demonstrate that the IDC and radionuclide laboratory results for Network QA/QC and Level 5 samples are in a good agreement, confirming reliable operation of the IMS network. For Category B split samples, the discrepancies in result comparison are larger as the activity may not be homogeneously distributed within the sample volume. Radionuclide laboratories provide high-quality and timely services in supporting the IMS Network. Strong collaboration between Station Operators, Radionuclide Laboratories, and the PTS ensures the successful implementation of the Network QA/QC Programme, despite occasional challenges related to the sample shipment process, including various environmental and political conditions.

The IMS Particulate Network QA/QC Programme is an effective tool for identifying issues at the IMS station level.

The QA/QC ^{7}Be metrics, established in accordance with the ISO 13528:2022 – Statistical methods for use in proficiency testing by interlaboratory comparison, have been proven to be effective in detecting potential issues at stations or laboratories that require immediate actions.

References

1. CTBT/WGB/TL-11,17/18/Rev.7 Operational Manual for Radionuclide Monitoring and the International Exchange of Radionuclide Data
2. CTBT/PTS/INF.96/Rev.10 Certification and Surveillance Assessment of Radionuclide Laboratories for Particulate and Noble Gas Sample Analysis
3. IDC-QMS-PLN-850 Particulate and Noble Gas Quality Assurance Plan
4. ISO 13528:2022(E) Statistical methods for use in proficiency testing by interlaboratory comparison
5. IDC-ENG-SPC-103-Rev.8 Formats and Protocols for Messages